Amendment to the Claims

In the Claims:

Please cancel Claims 1-18 and 21-22. Please add new Claims 23-45 as follows:

1.-18. (Canceled)

19. (Original) Apparatus for analyzing pulp fiber, comprising:

a flow cell that includes a passageway having an inlet, an outlet and a sample holding region between the inlet and the outlet that has a transparent wall;

a conduit for delivering a pulp fiber sample to the inlet of the flow cell, and through the inlet into the sample holding region of the flow cell, said pulp fiber sample including pulp fiber and a fluorescent stain bound to the pulp fiber;

a light source and a focused light path positioned to direct light through the transparent wall into the pulp fiber sample to stimulate fluorescence from the pulp fiber sample while it is in the flow cell; and

a fluorescence analyzer positioned to analyze fluorescence emitting from the pulp fiber sample and measure at least one property of the sample.

20. (Original) The apparatus of claim 19, wherein the light source is a xenon strobe lamp which outputs light from ultraviolet to infrared wavelengths, and said apparatus includes a filter that removes light outside of a desired range, a mirror used to reflect light from the filter towards the transparent wall of the flow cell, and an objective lens between the mirror and the transparent wall for focusing the light on the pulp fiber sample in the flow cell.

21.-22. (Canceled)

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23. (New) The apparatus of claim 19, further comprising:

a first dichroic mirror configured to direct light from the light source to the pulp fiber sample in the flow cell;

a second dichroic mirror configured to direct light from the pulp fiber sample in the flow cell, the second dichroic mirror allowing light having a first wavelength to pass through the second dichroic mirror, while reflecting light having a second wavelength;

a first detector configured to receive the light at the first wavelength that has passed through the second dichroic mirror and produce a corresponding first output signal; and

a second detector configured to receive the light at the second wavelength that has been reflected by the second dichroic mirror and produce a second output signal.

24. (New) The apparatus of claim 23, wherein the fluorescence analyzer comprises the first and second detectors and a processor that is logically coupled to receive the first and second output signals respectively from the first and second detectors, the processor being configured to utilize data derived from the first and second output signals to determine at least one property of the pulp fiber sample that is being analyzed.

25. (New) The apparatus of claim 23, wherein the first detector is angularly oriented substantially orthogonal to the second dichroic mirror.

26. (New) The apparatus of claim 19, further comprising an objective lens spaced from the transparent wall along a substantially straight image path that is substantially perpendicular to a beam of light emitted by the light source; said first dichroic mirror being positioned at about a forty-five degree angle with respect to both the beam of light and the substantially straight image path, and being disposed between the second dichroic mirror and the objective lens.

27. (New) The apparatus of claim 19, wherein the fluorescence analyzer is configured to determine both a fiber geometry and a lignin content of the pulp fiber sample.

28. (New) The apparatus of claim 19, wherein the fluorescence analyzer is configured to determine a fiber geometry, a total charge of the fiber, and a lignin content of the pulp fiber sample.

29. (New) The apparatus of claim 19, further comprising means to control an amount of stain in solution in the flow cell to an extent desired without undesirably reducing an amount of stain that is bound to the pulp fiber sample.

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30. (New) The apparatus of claim 29, wherein said means to control an amount of stain in solution in the flow cell comprises:

a fluid volume including a volume of bleach solution; and

a bleach solution supply line coupled in fluid communication with the fluid volume and the conduit, the bleach solution supply line being coupled in fluid communication with the conduit at a location proximate the inlet of the flow cell, such that before the pulp fiber sample passes through the flow cell, the bleach solution bleaches substantially all of the stain in solution, generally without bleaching the stain bound to the pulp fiber sample.

31. (New) The apparatus of claim 29, wherein said means to control an amount of stain in solution in the flow cell comprises:

a bleach fluid volume including a volume of bleach solution;

a slurry fluid volume including a volume of pulp fiber slurry including a stain both in solution and bound to the pulp fibers, the slurry fluid volume being coupled in fluid communication with the conduit;

a bleach solution supply line coupled in fluid communication with the bleach fluid volume and the conduit; and

a pump configured to drive the bleach solution and the pulp fiber slurry into the conduit to provide the pulp fiber sample, the pump controlling a relative ratio of bleach solution to pulp fiber slurry, such that the amount of bleach solution present in the flow cell is sufficient to bleach substantially all the stain in solution, generally without bleaching the stain bound to the pulp fiber sample.

32. (New) The apparatus of claim 19, wherein the fluorescence analyzer is configured to simultaneously acquire two images, a first image being acquired from a first camera configured to capture light having a first wavelength, a second image being acquired from a second camera configured to capture light having a second wavelength, the fluorescence analyzer processing the first and second images to extract a particle fluorescence ratio.

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33. (New) The apparatus of claim 19, wherein the fluorescence analyzer comprises:

a first camera configured to capture light having a first wavelength to produce a first image;

a second camera configured to capture light having a second wavelength to produce a second image; and

synchronization means to ensure synchronous acquisition of the first and second images by the first camera and the second camera.

34. (New) The apparatus of claim 33, wherein said synchronization means comprises a sync generator providing vertical and horizontal sync signals that are input to both the first and second cameras.

35. (New) The apparatus of claim 33, wherein the fluorescence analyzer is configured to process the first and second images by implementing the following functions:

multiplying the first and second images by a vignette correction image that flattens a field and calibrates a color sensitivity of each of the first and second cameras to achieve a calibrated image;

applying a binary threshold to the calibrated image to determine a number of bright pixels in the calibrated image; and

determining if the number of bright pixels indicates that the calibrated image includes a fiber, such that images not including a fiber are discarded, while images including a fiber are further processed.

36. (New) The apparatus of claim 35, wherein the fluorescence analyzer is configured to further process images including a fiber by implementing the following functions:

subtracting a dark-current image from the first and second images to generate a corrected image;

performing a background estimation using a low pass filter;

subtracting the background estimation from the corrected image to achieve a filtered image including fibers and noise;

applying a threshold to locate the fibers in the filtered image; and

quantifying mean intensities for the first and second wavelengths, perimeters of the fibers that were located, and an area of the fibers.

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37. (New) The apparatus of claim 36, wherein the fluorescence analyzer is configured to further process images including a fiber by calculating kink and curl indices of the fibers that were located.

38. (New) The apparatus of claim 36, wherein the fluorescence analyzer is configured to further process images including a fiber by identifying endpoints for each fiber located, and discarding data corresponding to any fiber located that includes more than two endpoints.

39. (New) A method for analyzing pulp fiber, comprising the steps of:

using a conduit to deliver a pulp fiber sample to an inlet of a flow cell, the pulp fiber sample including pulp fiber and a fluorescent stain bound to the pulp fiber;

introducing the pulp fiber sample into a passageway in the flow cell via the inlet, the passageway leading to a sample holding region disposed between the inlet and an outlet of the flow cell;

directing light from a light source along a focused light path through a transparent wall in the sample holding region and into the pulp fiber sample to stimulate fluorescence from the pulp fiber sample while it is in the flow cell; and

collecting fluorescence light emitted from the pulp fiber sample while the pulp fiber sample is in the flow cell; and

analyzing the fluorescence light emitted from the pulp fiber sample to determine at least one property of the sample.

40. (New) The method of claim 39, further comprising the step of preparing the pulp fiber sample by:

preparing a fluorescent stain solution;

adding a predetermined amount of pulp fibers to a predetermined amount of the stain solution;

mixing the predetermined amount of the pulp fibers and the fluorescent stain solution to disperse the pulp fibers in the fluorescent stain solution and create a slurry;

removing the pulp fiber sample from the slurry; and

mixing the pulp fiber sample removed from the slurry with a second solution to form a pulp fiber suspension, said pulp fiber suspension comprising the pulp fiber sample that has been prepared.

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41. (New) The method of claim 39, further comprising the step of introducing bleach into the sample holding region in an amount sufficient to substantially bleach any stain in solution, generally without bleaching the stain bound to the pulp fibers.

42. (New) The method of claim 41, wherein the step of introducing bleach into the sample holding region in an amount sufficient to substantially bleach any stain in solution, generally without bleaching the stain bound to the pulp fibers comprises the step of adding the bleach to the pulp sample just before the pulp sample enters the inlet to the flow cell.

43. (New) The method of claim 39, wherein the step of analyzing the fluorescent light emitted from the pulp fiber sample to determine at least one property of the sample comprises the step of determining a lignin content of the pulp fiber sample.

44. (New) A system for analyzing pulp fiber, comprising:

a flow cell that includes a passageway having an inlet, an outlet, and a sample holding region disposed between the inlet and the outlet, the sample holding region having a transparent wall;

a conduit for delivering a pulp fiber sample through the inlet and into the sample holding region of the flow cell, said pulp fiber sample including pulp fiber and a fluorescent stain bound to the pulp fiber;

a light source and a focused light path directing light from the light source through the transparent wall and into the pulp fiber sample to stimulate fluorescence emission from the pulp fiber sample while the pulp fiber sample is in the flow cell; and

a fluorescence analyzer positioned to analyze fluorescence emitting from the pulp fiber sample, the fluorescence analyzer comprising a controller configured to determine at least one property of the pulp fiber sample.

45. (New) The system of claim 44, wherein the controller is configured to determine a lignin content of the pulp fiber sample.

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